
Space Weather Technical Forecast

Issued on Thursday, 09 May 2024 at 13:36 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Further X-class flares (R3 - Strong radio blackouts) likely from AR3664. G1-G2 Minor-Moderate geomagnetic storm conditions expected later on the 10 May onwards with CME arrivals expected. Chance of G3 Strong geomagnetic storm intervals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is High with a double peak X1.0 flare from AR3664 at 08/2140 UTC and an X2.2 flare from the same region at 09/0913 UTC. This combined with frequent higher M-flares from both AR3663 and AR3664 during the past 24-hour period. There are seven sunspot regions on the visible disc, with two currently unnumbered small regions in the northeast quadrant. AR3664 remains, by far, the largest and most active flaring region on the disc. Areal extent continues to increase with consolidation of a number intermediate spots within the main penumbra regions, as well as small spots developing ahead of the leading main spot. The region remains extremely complex with multiple pronounced delta spots. Accurate assessment of AR3663 becoming increasingly difficult as it approaches the northwest limb, but there appears to be a waning in size and complexity resulting in a slight reduction in classification, although a delta spot configuration is tentatively maintained. The remaining sunspots on the disc are smaller, more stable and magnetically much more simple.

Multiple likely Earth-directed halo CMEs were observed leaving the sun through the 08 May, associated with flares from the large and complex AR3664. These CMEs are currently expected to arrive at Earth later on the 10 May or early on the 11 May, with impacts perhaps persisting into the 12 May. The most recent X2.2 flare at 09/0913 UTC looks to have produced another halo CME with full modeling and assessment pending further imagery. The large filament liftoff in the northeast quadrant, starting around 08/1807 UTC also produced a CME which was assessed as have a potentially glancing Earth directed component into the 11th, further complicating the forecast.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 declined slightly but remained at slightly elevated levels, 420-460km/s, as the connection to the HSS of CH35/+ continued to ease. Density remained below average throughout the period. The Interplanetary Magnetic Field, Bt, persisted at weak levels with peaks of 4nT. The north-south component, Bz, varied weakly between +3/-3nT. Phi angle remained positive (away from the sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was mostly at normal background levels, although indicated occasional responses to the flare activity, the latest of which is ongoing. High energy electron flux (greater than 2MeV) observed at GOES16 remained at largely background levels. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 09/0001 UTC was 7.96e6 integrated pfu on an upward trend.

Four-Day Space Weather Forecast Summary

Solar Activity: High solar activity is expected to continue, with frequent M-class flares expected and isolated X-class flares likely throughout, principally from AR3664.

Solar Wind / Geomagnetic Activity: There are multiple potentially Earth-directed CMEs in the forecast period. There remains a slight chance of glancing impacts through day 1 into early day 2 (09-10 May). Likely more significant CME impacts expected either later day 2 (10 May), or more likely early on day 3 (11 May), these from the combination of a sequence of larger halo CME's generated by X1.0 flares that occurred early and late on 8th May, and a slightly smaller M8.6 flare, all associated with AR3664. Some glancing influence is also possible from a large filament liftoff in the northeast disk on the 8th, this signal likely to be swamped by the previously mentioned CMEs however.

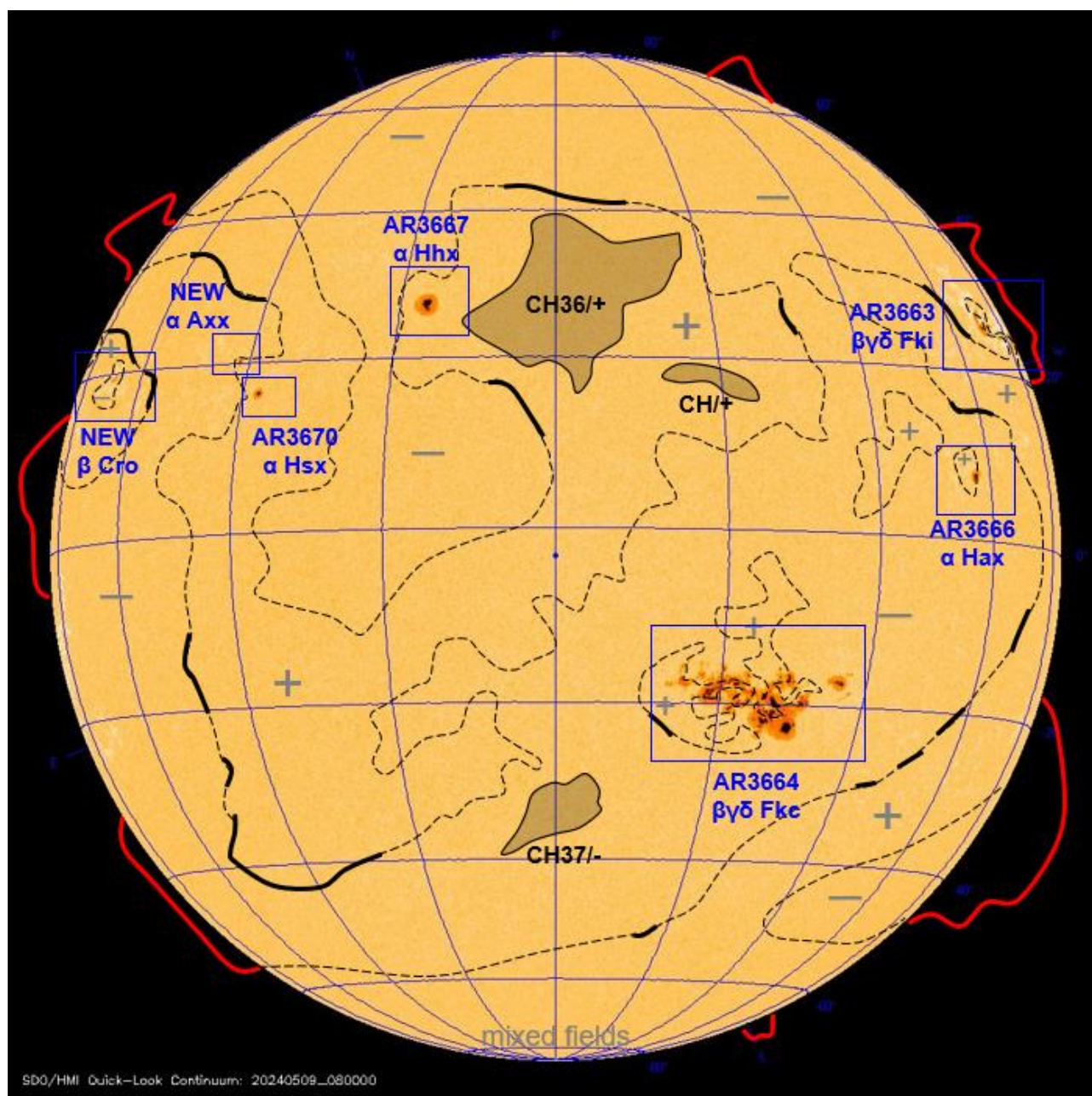
Outside of CME influence Earth seeing currently slightly elevated solar winds likely to fall to background levels by day 2 (10 May). With weak HSS influence possible from late day 3 (11 May) onwards.

Geomagnetic activity likely remaining Quiet to Unsettled to start the period, with just a slight chance of isolated Active to Minor Storm (Kp5) intervals. Activity should increase to G1-G2/Minor-Moderate (Kp 5-6) Storm levels, with a chance of G3/Strong (Kp 7) Storm conditions from later day 2 or perhaps more likely early day 3 (10-11 May), with these elevated conditions expected to persist into day 4 (12 May).

Energetic Particles / Solar Radiation: There is an ongoing chance for an S1/Minor Storm or greater event throughout the period associated with significant flaring from AR3663 and AR3664.

High energy electron flux is forecast to be at background to moderate levels throughout, with associated fluence expected to remain well below the Active ($1e8$ integrated pfu) threshold.

Figure 1. Solar Analysis Valid 09/0800UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are multiple potentially Earth-directed CMEs in the forecast period. There remains a slight chance of glancing impacts through day 1 into early day 2 (09-10 May). Likely more significant CME impacts expected either later day 2 (10 May), or more likely early on day 3 (11 May), these from the combination of a sequence of larger halo CME's generated by X1.0 flares that occurred early and late on 8th May, and a slightly smaller M8.6 flare, all associated with AR3664. Some glancing influence is also possible from a large filament liftoff in the northeast disk on the 8th, this signal likely to be swamped by the previously mentioned CMEs however.

Outside of CME influence Earth seeing currently slightly elevated solar winds likely to fall to background levels by day 2 (10 May). Within the past 24 hours a new, small positive coronal hole has developed in the western hemisphere, and weak HSS influence is possible from late day 3 (11 May) onwards although this is likely to be masked by the effects of the potentially significant CME arrival.

Geomagnetic activity likely remaining Quiet to Unsettled to start the period, with just a slight chance of isolated Active to Minor Storm (Kp5) intervals. Activity should increase to G1-G2/Minor-Moderate (Kp 5-6) Storm levels, with a chance of G3/Strong (Kp 7) Storm conditions from later day 2 or perhaps more likely early day 3 (10-11 May), with these elevated conditions expected to persist into day 4 (12 May).

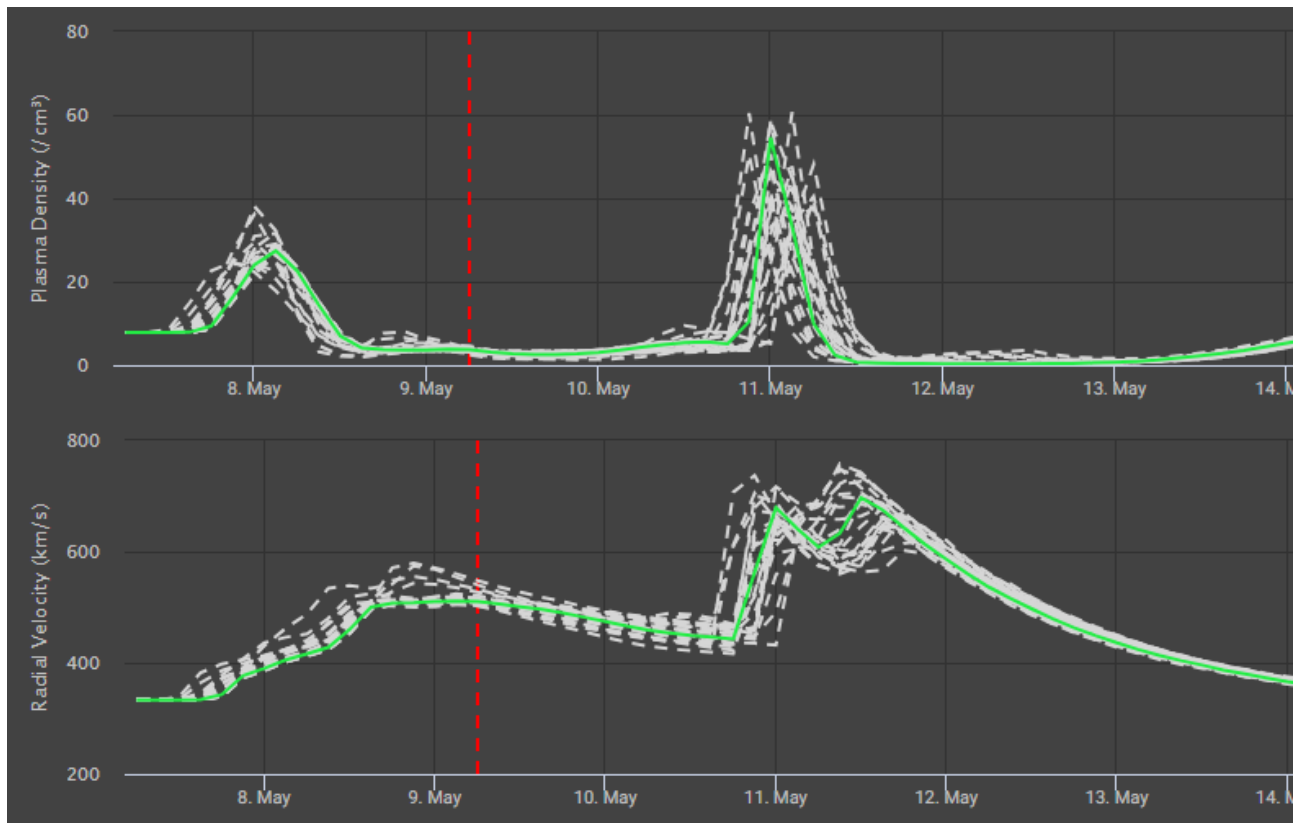
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	80	90	80
Strong	G3	No	1	30	40	30
Severe	G4	No	1	5	10	5
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0251	Partial	Filament	SE	323 km/s	10/1200 UTC	Slight chance of glancing blow
08/0927	Full	AR3664	SW	850 km/s	11/0000UTC +- 6hr	Merges with below
08/1200	Partial	AR3664	SW	715 km/s	11/0000UTC +- 6hr	Merges with above
081840	Partial	Filament	NE	600 km/s	11/0600UTC +- 6hr	Glancing blow. Merges with below
08/2140	Full	AR3664	SW	902 km/s	11/0600UTC +- 6hr	Merges with above



Figure 2: Latest MOSWOC ENLIL Ensemble output



Radio Blackouts - X-Ray Flares:

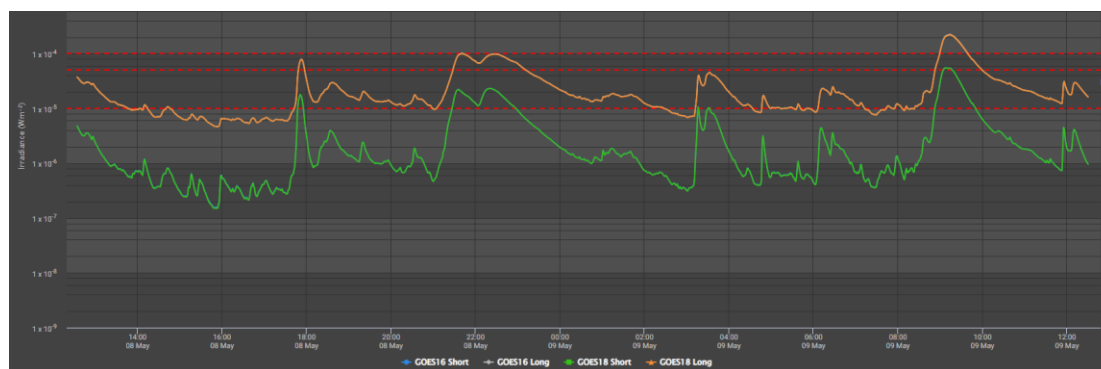
There are seven sunspot regions on the visible disc, with two unnumbered small region in the northeast quadrant, and the previous AR3668 now merged into AR3664. AR3664 remains, by far, the largest and most active flaring region on the disc. Areal extent has increased with consolidation of a number of the smaller spots into the broader penumbra regions. It comprises a number of strong spots with significant mixing of its constituent magnetic polarities. This is particularly evident in its intermediate portion and with the region displaying an extremely complex Mt Wilson Beta-Gamma-Delta configuration containing multiple delta spots. Accurate assessment of AR3663 is becoming increasingly difficult as it approaches the northwest limb, but there appears to be a waning in size and complexity resulting in a slight reduction in classification, although a delta spot configuration is tentatively maintained. The remaining sunspots on the disc are smaller, more stable and magnetically simple.

AR3663 is due to rotate over the western horizon on day 2 (10 May) with the flare risk from this region then beginning to slowly decrease. Far-sided helioseismographs indicate a number of returning regions over the eastern horizon in the coming days that may supplement the present risk of significant flares should they persist. However as AR3664 currently provides the vast majority of the flare risk and remains on the visible disk throughout, the current risk level is maintained through the forecast period pending further developments.

High solar activity is expected to continue, with frequent M-class flares expected and further isolated X-class flares likely, principally from AR3664 but also initially from AR3663.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	95	95	95	95
Very Active	R3 to R5 X Class	Yes	60	60	60	60

Figure 3: Latest 24hr GOES 16/18 X-ray flare trace



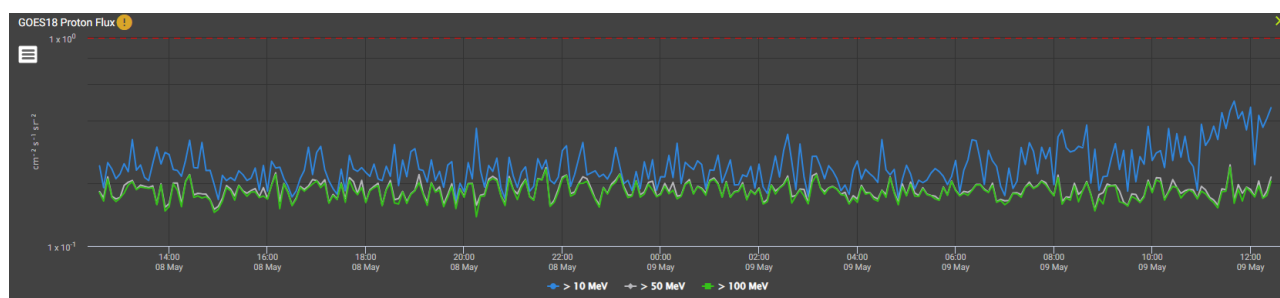
Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV) observed at GOES-18 has remained at generally background levels despite recent significant flaring, there is a chance however of an S1/Minor Storm or greater event occurring on all days, from both AR3663 as it rotates around the northwestern limb in the coming days and increasingly from AR3664 as this region moves into the western solar hemisphere.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	40	40	40	40
Very Active	$\geq \text{S3}$ *	No	5	5	5	5

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: Latest 24hr GOES 18 Proton flux trace



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux is at normal background levels. Likely CME and coronal hole influences through the period are expected to limit electron flux to background to moderate levels on all days.

Overall, the 24 hour integrated electron fluence is forecast to remain well below the Active ($1\text{e}8$ integrated pfu) threshold, despite the current upward trend. The Met Office REFM model is therefore considered to be giving good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	1
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: Latest MOSWOC REFM model output

